

West Chicago's Struggle Against Radioactivity and a Corporate Giant:
Utilizing Spatial Interpolation to Analyze Thorium Contamination

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Abstract

Before electric lights became commonplace, lanterns could be found lighting streets and homes. A way to make them burn brighter and longer was to infuse thorium nitrate into the fibers that wicked the fuel to the flame. The City of West Chicago, Illinois, hosted one of the largest factories in the world dedicated to creating the thorium nitrate for these lanterns. One byproduct of this process was a sandy substance called thorium mill tailings. These tailings built up on the factory grounds until the owners, Lindsay Light & Chemical Company, later American Potash Company, and finally Kerr-McGee, gave these tailings away as free landfill to construction crews, a municipal landfill, a water treatment plant expansion, and regular citizens wanting to fill in low spots in their yards. It was determined during a monitoring survey flight for nearby Fermilab that something was creating a radiological footprint in West Chicago that was out of the ordinary (EG&G, 1981). Eventually it was made common knowledge that thorium was radioactive, and the factory had knowingly given out contaminated fill material.

This proposal and capstone paper explores the history and industrial uses of thorium and the history of the eventual involvement of the United States Environmental Protection Agency and Nuclear Regulatory Commission in the fight over what was to happen to the contaminated properties. It will also explore the various effects on human health thorium and its related elements – uranium, radon, thoron, etc. – may have had on the community, as well as similar cases around the world of thorium contamination and its effects on miners and workers in refineries. Spatial interpolation will be used to examine the extent of contamination under a road right-of-way as well as examine the distribution of contaminated parcels. Finally, this proposal will review the legislation and various reports that came about from the situation in West Chicago, including clean up, costs, and future plans for the affected sites.

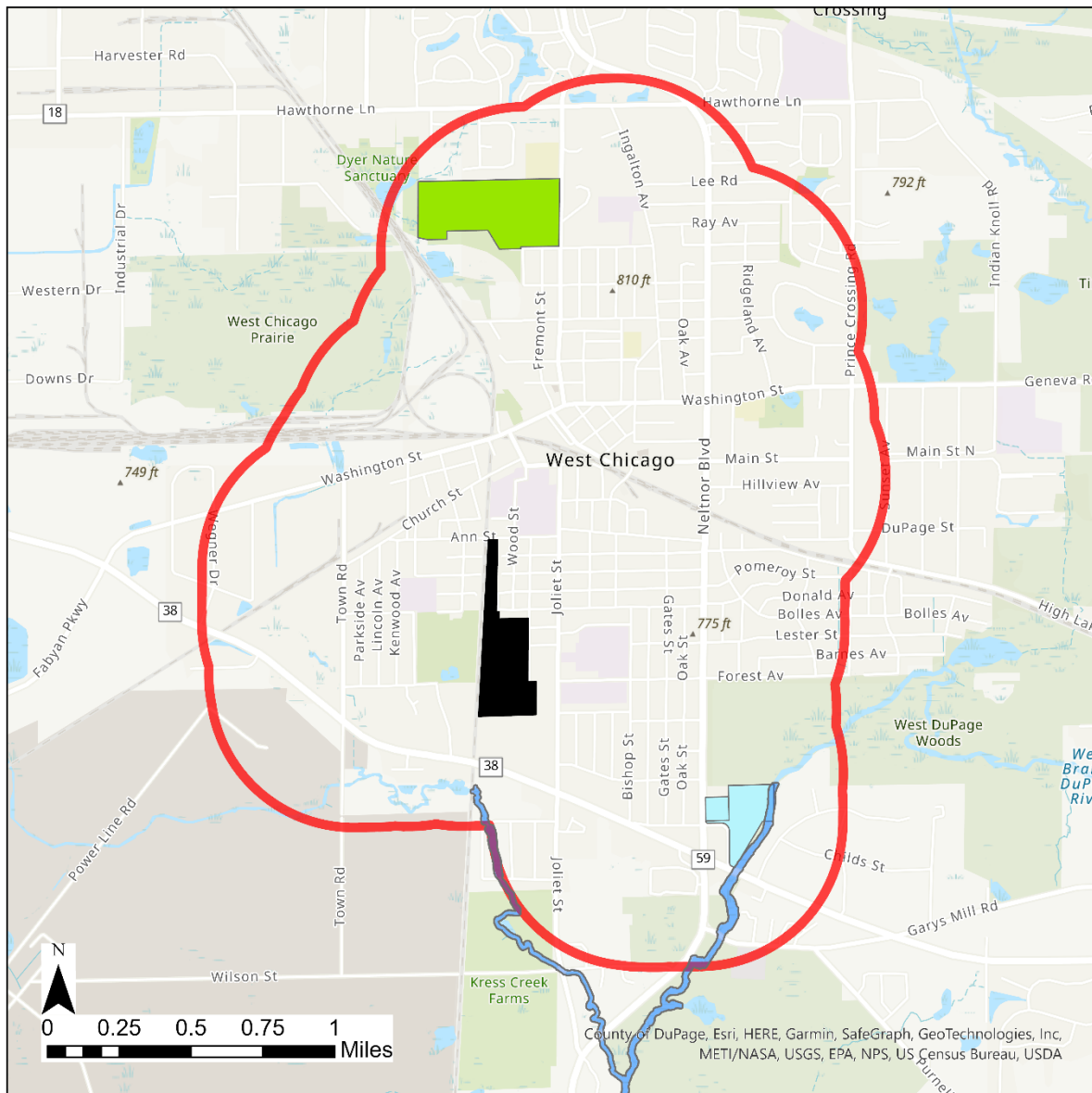
Introduction

From the 1930s through the early 1970s, West Chicago was a boomtown of industry, building upon its historic roots as the town where three large branches of the railroad industry intersected. At the same time, it was unknowingly poisoning itself with radioactive waste from the Lindsay Light & Chemical Company factory and its successors, American Potash & Chemical Corporation and Kerr-McGee Chemical Corporation. This radioactive waste was in the form of thorium mill tailings, a byproduct of the process to make an element in gas lanterns that burned brighter and longer than any element before it. The mill-tailings were given away for free by the company to be used by the community. Rainwater runoff from the factory site polluted a creek which feeds a recreational pond in a subdivision, then into a river system which goes through a forest preserve and other residential areas. Ted Hogan, an associate professor at Northern Illinois University, grew up in the area and remembers seeing deformed tadpoles as a child playing in the water (Flores, 2022).

At the factory, raw monazite ores were refined to extract thorium and mix it with various chemicals to make it usable in the lanterns. Thorium and many of its daughter elements give off alpha-, beta-, and gamma-radiation, which have been found to be detrimental to human and animal health. Lead, while not radioactive, appears twice in the decay series of thorium, as does radium and polonium (Polednak, et al, 1983). Despite it not being radioactive, lead is well-known to be detrimental to human and animal health.

A state-sponsored series of studies on Chinese miners of monazite ore and a study by Argonne National Laboratory in the United States on former workers at the Lindsay Light & Chemical Company revealed working with thorium and its associated elements and particles can be harmful to one's health (Chen, et al, 2004, Polednak, et al, 1983). In 1976, an anonymous call to a local newspaper "led to a Nuclear Regulatory Commission investigation" (Carey v. Kerr-McGee Chemical Corp), which revealed an urgent need to remove the contaminated factory remains and the free mill tailings throughout the city because citizens were using the mill tailings in their gardens, sandboxes, and in some cases, the foundations for the houses themselves (Huska, 2022). Early on, residents living near the factory site claimed the uncontrolled pollution and fumes "would turn windowpanes blue and rot the curtains right off their rods" (Robeznieks, 1991). One study also appears to suggest this is when Kerr-McGee and its predecessors learned about how widespread and potentially dangerous the effects of thorium were (Frigerio, et al, 1978).

Kerr-McGee Factory in West Chicago, IL Highlighting Thorium-Contaminated Areas



Legend

- Factory Parcels
- Water Treatment Plant
- Reed Keppeler Park
- Polluted Waterways
- Affected Residential Area

This map of West Chicago, Illinois shows the former Kerr-McGee factory site in a now-residential area of the city. The grey buffer encompasses all of the contaminated parcels identified thus-far. Two waterways, Kress Creek and the DuPage River, as well as Reed-Keppeler Park and the Water Treatment Plant, were also affected by thorium contamination.

Created by: Ben Stone,
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Institution: The University of
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Spatial Reference: NAD 1983
StatePlane Illinois East FIPS
1201 (US Feet)
Sources: U.S. Census, DuPage
County GIS

Problem Statement & Objectives

Research Questions:

1. When did Kerr-McGee and its predecessors know about thorium's potential to cause detrimental health effects in factory workers and West Chicago residents?
2. What, if any, findings were made from studies which focused on exposure to thorium in Chinese monazite ore miners and West Chicago thorium refinery workers?
3. How did the process of removing contaminated materials both on- and off-site come to fruition? I.e. timeline, funding, delays, involved parties.

Hypothesis:

Central hypothesis: Exposure to monazite, uranium, thorium, and their daughter particles and associated radiation leads to detrimental health effects and premature deaths post-exposure.

Data to be utilized: The initial and follow-up studies focusing on Chinese miners of monazite ores (Chen 2004), and studies done on thorium refinery workers from West Chicago (Conibear, 1983)(Najeem and Voyce, 1990)(Polednak, et al, 1983).

Expected Outcomes & Deliverables

The deliverables will be the report itself, maps of West Chicago parcels that have been excavated and cleaned of contaminated soil, charts of a borehole study of a road built over the former landfill, a series of Inverse Distance Weighting images of the borehole study, and, if time and quality of data allow, an online interactive map. A map has already been made showing the areas affected by the Kerr-McGee factory site, which is of an aerial view of the City of West Chicago. The author plans to make a map showing which properties were identified in radiological study flyovers as well as which properties had their contaminated soil excavated and replaced (for the data available – it is largely being withheld by the EPA due to privacy concerns). Lastly, data permitting, the author is considering making a heat density map which highlights where the majority of excavated properties are. The charts made will be of various results from reports found. Quality assurance has been an issue for this project and has required the author to set aside many hours of reading hard copies of long reports, sorting through relatively unorganized storage bins, browsing hundreds of pages online, and downloading hundreds of PDF documents to read. The author only intends to include data which is found within a whole report and can verify who or what agency published, funded, or requested it.

Research Background

In West Chicago, Illinois, there is a large swath of land that will almost certainly never be developed beyond open parkland (Kerr-McGee Cleanup to Conclude: City Prepares for Future Park at Site - City of West Chicago, Illinois, 2022). This is because of a series of factories that once occupied the parcels that make up the property, and what they specialized in: refining monazite ores to create thorium nitrate, a substance once used in lanterns to give them their glow and longevity. The processing of thorium took place as far back as the 1930s, continued for decades, and produced a waste product called thorium tailings, which was sand-like in texture and used as backfill to level front- and backyards, stabilize land in wetland areas, and

raise the surface level of land above the wetland water table. Thorium is a daughter element of uranium and as such is radioactive. Essentially, the citizens of West Chicago were unknowingly spreading radioactive dirt throughout their community.

Eventually, rates of cancer in the area became elevated above what the expected average rate would be for the community (Huska, 2022), and with the advent of nuclear knowledge becoming more widespread during the Cold War with classics such as “Duck and Cover” being played for schoolchildren in preparation for a nuclear strike, people began to take more notice of the factory. An anonymous call to a newspaper eventually led to a massive cleanup effort after years of sluggish, back-and-forth litigation, and the revelation that the factory had also been utilized to process materials to be used in the Manhattan Project during World War II (Roe and Manier, 2001). Hundreds of private residences had to be excavated, some even lifted off their foundations and moved to alleyways, removing hundreds of thousands of pounds of contaminated soil. Trees, pools, and sheds were among the yard fixtures that had to be removed. The sewage treatment plant, which was expanded upon in the mid twentieth century into the West Branch of the DuPage River’s floodplain, had to be carefully remediated due to its use of thorium tailings as backfill. Numerous parks in the area, as well as the entire Kress Creek waterway and a substantial portion of the West Branch of the DuPage River, had to be restored.

This capstone project aims to be a novel source of knowledge for contemporary readers, as many of the reports and findings date back thirty or more years ago. These reports are heavy in industry jargon, making them hard to interpret through a twenty-first century perspective, especially among those not familiar with spatial analyses and the effects such a large amount of radioactive contamination can have on an idyllic midwestern community and its citizens. There will be a written portion of the capstone, and a goal of creating an online interactive map where the reader will be able to see how the site has looked at various stages of its history, to see which properties were evaluated and which were excavated, and display the success stories of the remediation efforts.

The sources utilized range from site-specific documents produced by the United States Environmental Protection Agency, Nuclear Regulatory Commission, City of West Chicago, and Kerr-McGee and its subsidiaries. The author plans to interview their undergraduate advisor, who specializes in contaminant hydrogeology and groundwater pollution studies, as well as a former coworker, who has worked on cases of environmental pollution and its effects on citizens in comparable sites in contemporary times. Both have expressed significant interest in this project. The author is in contact with a woman who has been featured in many articles, wrote and directed her own documentary on the site, conducted door-to-door surveys, lived next to the site, and developed leukemia twice – theorized to be a result from her close proximity and childhood spent playing in and near the factory site. In addition, the author plans to use a variety of articles about thorium, its potential uses, dangers, and history, as well as a number of case studies focusing on thorium’s effects on miners and workers in factories that process it. The author has also been in contact with the West Chicago History Museum and the Environmental Protection Agency Region 5 office in Chicago, and is awaiting the processing of multiple Freedom of Information Act requests.

Having grown up just a block away from the factory site and knowing multiple friends and neighbors who have, or have succumbed to, various forms of cancer and other severe

illnesses, this project is becoming an eye-opening and sobering experience in learning about a dark chapter in the history of the author's hometown.

Technical Approach: Study Region / Data / Proposed Methods

Study Region

This research project focuses on four areas near a former thorium refinery factory once located in the City of West Chicago, in west suburban DuPage County, Illinois. The thorium refinery, from its opening in the 1930s until the 1950s, would give away a byproduct - mill tailings - for free to residents looking to fill low spots in their yards, to contractors for backfill in construction, and to the city itself for municipal projects. Some of these projects included expanding the water treatment plant and a small landfill in what is now Reed Keppler Park.

These mill tailings were contaminated with radioactive thorium, allegedly causing an abnormally high rate of cancers and other illnesses in the region. The four study regions for the research project are the factory grounds and the residential areas surrounding it, as well as the contaminated park, water treatment plant, and a waterway contaminated by rainwater runoff.

The climate of West Chicago is that of a typical Midwestern suburb – cold, dry winters and hot, humid summers. Spring and Fall in the region are generally calm, with comfortable temperatures and sporadic rainfall. The roads are paved with concrete or asphalt, except for a few gravel driveways and private alleyways scattered around town. The demographic characteristics of the city have steadily been leaning towards a Latino majority. The city is largely made up of blue-collar working-class citizens speaking a mixture of English and Spanish.

Data

To shape the project as the author sees it, they will need a list of residential addresses that were identified as having contaminated soil and a list of addresses that had the contaminated soil excavated from the property.

The author has recently met with a woman who once lived near the factory property who was diagnosed with leukemia in her mid-twenties after a childhood spent playing in the abandoned factory buildings. When she received her diagnosis, her friend suggested the thorium refinery may have been related. She set out to survey her former neighbors to see if anyone else had been diagnosed with any cancers or diseases, conditions, etc., that could be attributed to thorium, its daughter particles, and their associated radiation. She stopped her survey after just over two hundred entries due to the emotional weight it was creating for her. Thankfully, she has been open and forthcoming with the materials she has since collected regarding the factory site. She has taken part in many interviews and even directed her own short film on the topic (Bartlett, 2022).

This woman provided the author with a list of addresses that were distributed to participants in a class action lawsuit against Kerr-McGee. The lawsuit was seeking monetary compensation for medical monitoring – the first of its kind in the United States – and won. The author plans to use a parcel map of West Chicago and cross-reference it with the address list to create a visual representation of properties involved. This would likely take the form of a form of a heat map, where areas with sparse contaminated parcels would appear “cold” and areas with dense contaminated parcels would appear “hot,” with cold areas being green or blue and hot areas being orange or red.

Using the list of addresses that were surveyed, the author can create a map where the parcel is color- and pattern-coded to show what the survey result was. For example, if a person is still alive but was diagnosed with cancer, the parcel would be red. If the person had cancer and is now deceased, the parcel would be red with hash marks going through it.

The author has visited the West Chicago History Museum and spoken with its director about this project, and they have said they are happy to help in any way possible (Phalen, 2022). However, their collection is mostly physical - in the form of records in boxes, and it is difficult to find data without knowing what exactly is in the boxes in the first place. That said, they have provided several digital scans of newspaper clippings and photographs. They also showed the author one of six Lindsay Light & Chemical Company lanterns they have, which were the products made at the thorium refinery. They regularly take measurements of them using a Geiger counter to ensure they are [relatively] safe to keep around. The author anticipates making more trips there in the future.

The author is in the process of collecting their own information from publicly available documents through the Environmental Protection Agency's website, scholarly websites such as Web of Science and Google Scholar, as well as Freedom of Information Act requests. The author may travel to Chicago to visit the Region 5 Office of the EPA - which manages sites in Illinois - which has reports and images that were not allowed to be uploaded to public-access websites due to privacy concerns. In addition to documents, the author has obtained historic and current aerial imagery of the site, which they plan to present in a series of photographs showing how the area around the factory changed from open fields to residential areas intermingled with schools and commercial buildings (Illinois Clearinghouse). On the paper portion of the project, this would be a photo series of left-to-right images; the left-most image would be the oldest, and the right-most would be the most recent. If time allows, the author may create a project on Google Earth Editor using an interactive slider to show the difference between two images across time, to be linked to as a digital accompaniment to this project.

The information gathered from this research will be a mixture of the history and use of thorium, the history of the factory site and its various occupants, a summarization of area-wide radiological surveys, health surveys on workers from the thorium refinery in West Chicago, as well as a series of studies on monazite (an ore containing thorium) miners in China, and information about how the contaminated sites have been cleaned up to EPA standards and how those standards came to be. The last portion will revolve around potential future uses of the site as proposed by various community members throughout the years. The research project itself will roughly follow the order of the items listed above.

Currently, the project is a combination of shapefiles within a geodatabase and PDF files of reports arranged in hierarchical folders on the author's Dropbox account. This account is continuously synchronized between their desktop PC, laptop, and cell phone. Eventually, the author plans to create Excel spreadsheets of the address datasets, to join to existing and derived shapefiles, and placing them in the Dropbox account as well. From the start of this project up to the present, the author's data management preferences have changed, and the author presumes they will continue to evolve and morph into new practices over the remainder of the project, depending what information and data is obtainable. Once the project is completed and polished, the author hopes to upload it to their GitHub profile and portfolio, as well as an ArcGIS Online map series.

Proposed Methods

For one portion of the proposal, the author wants to use a heat map and spatial interpolation to visualize where the most contaminated properties are in relation to various sites in West Chicago. This would be done by joining an Excel spreadsheet to the attribute table of the parcel shapefile. The joined table will have a column titled “Contaminated/Not Contaminated.” The addresses from the lawsuit list would likely be utilized for this portion over the list of addresses gathered from the house-to-house survey. It has been a number of years since the author last created a heat map, so creating one for this project will require them to practice with multiple iterations of the heat map until the results are satisfactory.

The spatial interpolation portion will be done with a borehole study on Yale Street, a street that was built on top of the radioactive remnants of a municipal landfill which is now Reed-Keppler Park. This will likely be in the form of Inverse Distance Weighting. The images produced will be shown in the report as a series of left-to-right images, and if time allows, an interactive element will be produced and stored in an ArcGIS Online map.

The heat maps would follow a similar convention to those found in “Determining the Tourist Attractive Regions by GIS Analysis Using Heatmaps,” by Viktoriya Kulyk and Rostyslav Sossa, published in 2018. Kulyk and Sossa use GIS-based heat map visualizations of tourist activity in Ukraine prior to the Russian invasion. In their report, Kulyk and Sossa use various approaches such as point-density of castles, religious buildings, and zoos to create a heat map showing where concentrations of the points of interest are highest (Kulyk & Sossa, 2018).

Management Plan

In January 2023, the author plans to have finished gathering all source material for the capstone project. They plan to have the sections of the capstone figured out and begin sorting the source material into those sections. In February, the author will be gathering data for the maps and charts and ensuring the data are sufficient. Once that is complete, the author will determine which maps and charts they are able to create, and create different versions of each. The author will collaborate with reviewers to determine which version to include in the final draft of the capstone. In March, the Science Background and Significance sections will be written, as well as the Introduction and Problem Statement and Objective sections. Finally, in April, the final maps and charts will be created, and the author will ensure all sources in the report are properly documented and cited throughout. The author will also write and formulate a title for the project, then conduct a final read and edit as the reviewers suggest.

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