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Final Draft

Environmental Risk Index for Commercial Properties in Richardson, TX

This project develops a parcel-level environmental risk index for commercial properties in Richardson, Texas. I used publicly available FEMA flood hazard zones, EPA Underground Storage Tank (UST) data, and municipal parcel and zoning datasets. My goal is to create a tool that supports early-stage environmental due diligence by identifying parcels that can have a potential environmental concern before a formal Phase I Environmental Site Assessment (ESA) is conducted. All datasets were processed and integrated into ArcGIS Pro, where UST locations, flood-prone areas, and commercial parcels were clipped, cleaned, and spatially analyzed to easily visualize environmental patterns across the city. My initial results show clear clusters of USTs within industrial and commercial areas and highlight parcels that intersect with both contamination and flood hazards. Although there were clear clusters, my final product which integrated the weighted risk scores tells a slightly different story. This study demonstrates how GIS-based tools can improve efficiency in the due diligence process and provide a replicable framework for lenders, investors, and environmental professionals. This is scalable to other cities and regions. This tool can help contribute to bridging the gap between traditional real estate practices and more data-driven environmental risk assessment.

Environmental due diligence plays a significant role in commercial real estate transactions by identifying potential environmental risks that can influence decisions in property valuations, and financing. Lenders, investors, buyers, and environmental professionals reply on multiple sources of data to determine if a property might have environmental issues. That can be contamination concern, if the property is at risk from flooding or other potential environmental hazards. The current methods in collecting and analyzing this data for use in Phase I environmental assessments still rely on reviewing each document manually and an in person site reconnaissance, this is the way it's done, although some professionals are now introducing AI to help summarize data, there is still a lack of tools to get preliminary findings at a glance, which can alert stake holders ahead of a site assessment.

My project develops an environmental risk index for commercial properties in Richardson, TX, I am using ArcGIS Pro as my main tool and integrated publicly available data to visualize potential risks. The end goal is to create a weighted spatial model that helps identify high-risk properties, which supports the initial stages of research in the due diligence process. In a larger scope this project aims to improve efficiency for Phase I assessments, with a weighted risk tool to identify RECs before any field work is conducted.

GIS has become more accessible and has led to the growth in environmental risk mapping. This growth has been seen in both urban and real estate analysis. In real estate transactions, audits, and appraisals it is important to identify characteristics of the subject property. Environmental due diligence (EDD) is an important step of real estate transactions because it helps to identify environmental risks that could affect the property's value, possible investment decisions and depending on the results in the EDD stage can also expose the owners and investors to liability issues. Property owners are responsible for the contamination of a property even if they did not cause it. Lenders are also responsible for any environmental contamination of the property. Phase I assessments and other related evaluations (Radon screening, Asbestos screenings, etc..) are becoming standard practices. The hope is that these assessments can provide protection against liabilities and being more informed on the subject properties can help make better decisions by identifying hazardous waste, and flood hazards. Although there have been rapid advances in GIS and technology in business, real estate is still a stubborn industry which has been historically driven by traditions and relationship driven culture. (CenterCheck 2025)

Previous studies have shown that proximity to environmental hazards and natural risks like floodings can alter property values. Properties in the FEMA flood zones usually sell for less than parcels outside a flood zone. (Dachary-Bernard 2025). Climate risks like flooding and contamination are priced into real estate prices and can influence financial risk. In another study, Mr. Prinsloo focus on the due diligence of planned agricultural floating solar systems and echoes this projects need for the “development of a GIS-based decision support tool for environmental impact assessments and die-diligence analysis” (Pinsloo 2019) Another study highlights how environmental hazards can be systematically quantified and communicated to stakeholders using decision-support tools, a gap that remains underexplored in the lending process for commercial real estate. The referenced study focuses on how coal mining in Portugal causes environmental contaminants into the soil and water. (Duarte et al 2022)

Tools for environment due diligence like the Phase I ESAs asses the environmental history of a property. Even though there have been advances in GIS and the greater accessibility of data than historically has been available, the commercial real estate industry is stubborn to change. Relationships and business transactions still heavily rely on personable relationships and traditional methods. The industry is slow and hesitant to adapt and adopt automated risk systems.

Other research has applied GIS based decision tools for site selection and impact analysis, but this is being used in other sectors. I have found more tools being used for determining these risks and have failed to find the replication of these tools for supporting decision-making in the lending process. One source brings up this issue. Mr. Prinsloo focus on the due diligence of planned agricultural floating solar systems and echoes this projects need for the "development of a GIS-based decision support tool for environmental impact assessments and die-diligence analysis" although his tool is aimed to help determine the environmental feasibility for these solar systems in the agricultural sector, it does not translate into the EDD in real estate to determine risks. Similarly, Duarte et al. (2022) used WebGIS with decision analysis to map potential environmental hazards around waste sites. These examples highlight the potential of geospatial tools to help enhance environmental assessments.

The area of study is the City of Richardson, TX, I chose this city as a pilot study. The city's website has open data that were valuable and necessary for my analysis. Key data sets include FEMA flood map from the FEMA flood map service center that describes the flood frequency in a geographic area. EPA underground storage tanks (UST) finder data shows geolocated single points that help identify active and inactive underground storage tanks, which can raise a flag on contamination risk. I also used the City of Richardson

Zoning and Parcel database to apply the city limits boundaries and apply parcel data by land use which I filtered to only show commercial, retail, and industrial properties.

All data sets have been processed and organized in ArcGIS Pro. With the EPA UST dataset, it originally covered the entire US but I isolated the city of Richardson in the data set so it can only show those points as that is my subject property. For the flood layer I used the flood risk layer for the entire United States and clipped it to the City of Richardson boundary, now my layers are all within the correct boundaries. I consolidated the high-risk markers into one easily identifiable blue color, while I chose purple for low to moderate flood risk areas.

My preliminary visualization is the City of Richardson boundaries map combined with the layer of UST data from the EPA, the layer was created to remove all other US cities in the original dataset. I used ArcGIS Pro to create my map and visualize my preliminary map. I had already identified clusters based on USTs alone. Once I finished cleaning up the parcel data, I added it to my map.

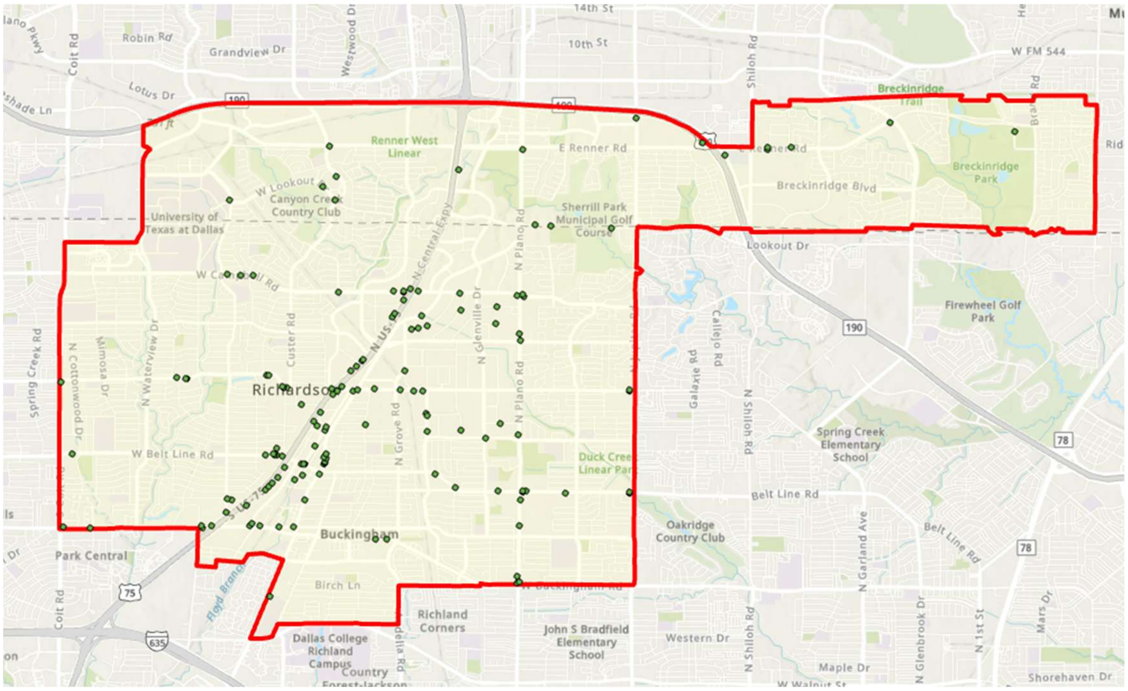

Figure 1: Initial USTs in the City of Richardson

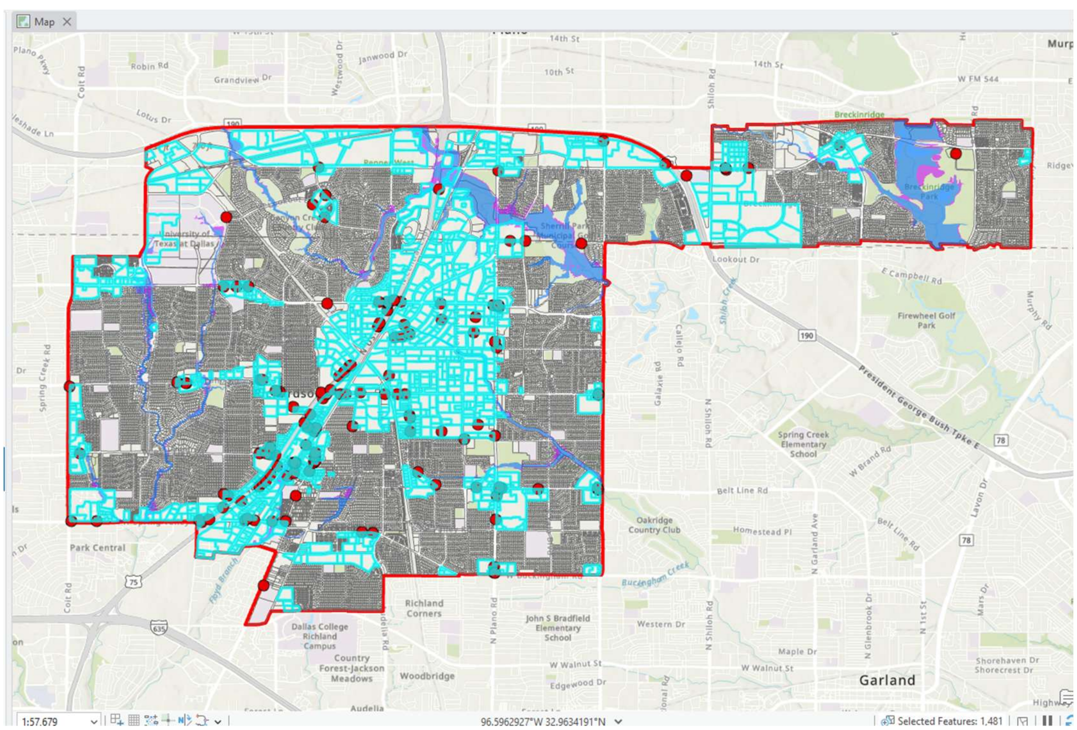

Figure 2:Map of Richardson, TX showing commercial parcel boundaries, FEMA flood hazard zones, and EPA Underground Storage Tank (UST) sites. This visualization highlights areas where flood-prone parcels overlap with potential contamination risks.

The blue polygons show parcels zoned for non-residential land use (industrial, commercial, retail), while red points represent USTS. The overlay reveals the spatial clustering of USTs within commercial and industrial areas, notably along central Richardson and around US 75, a major transportation route in the Dallas area. The spatial relationship highlights the areas where environmental risk factors, such as potential soil or ground water contamination are. Additionally, it shows that these environmental risk factors coincide with areas of denser commercial land use. These patterns observed show an earlier analysis of parcels that already may need further investigation past a Phase I Assessment towards a Phase II Subsurface Investigation. This also lets me know the parcels closest to the USTs will have higher risk scores.

At this point I also noticed my map looked a bit cluttered and decided to remove all the parcels not classified as industrial or commercial. This cleaned my map, so the relevant parcels were easily distinguishable. Then I was able to create the weights, in the composite environmental risk model, flood risk was assigned the highest weight at 40% because flooding represents a larger hazard with the moat potential for widespread damage, hazardous material release, and long-term environmental impact across multiple parcels. Land use was given a 30% weight because the type of activity occurring on a parcel directly influences the possibility of environmental risk or contamination potential at that site. How close to underground storage tanks (USTs) was also weighed at 30%, this shows its importance as a point-based hazard that can contribute to localized contamination, especially for parcels close to petroleum storage. This weighting structure ensures the model reflects both regional hazards (flood zones) parcel-level risk factors (land use and UST), creating a balanced and realistic composite score.

Once the individual hazard layers were calculated and joined to the commercial parcels, I combined them into a single composite environmental risk layer using the weighted risk model. The composite scores generated were then classified into four clearly defined categories (Low, Moderate, Elevated, and High Risk.) Using a graduated color scheme made these categories visually intuitive, this way parcel-level risk patterns can be easily interpreted immediately. This final classification shows a clear visualization of which areas of Richardson have the greatest combined environmental vulnerability.

Some challenges I ran into firstly with the UST data set, this shows nationwide data and does not show city level boundaries or data. Filtering required manual attribute selection. Another challenge was the flood zone data, again this data shows the entirety of the United States and did not allow for filtering by city boundary. I used my City of Richardson city limits layer to clip both datasets so only the relevant data was added to my map. Once added I had fifteen classes within my flood zone layer, I did not need that many classes to identify flood zones. I removed the reference to coastal classification as this is not a costal geographic area. Instead, I consolidated “high-risk” flood zones into one identifier to be able to see either high-risk or low/moderate-risk colors. Figuring out the best way to create risk scores was a challenge but using my better judgment I was able to identify which posed the greatest risk.

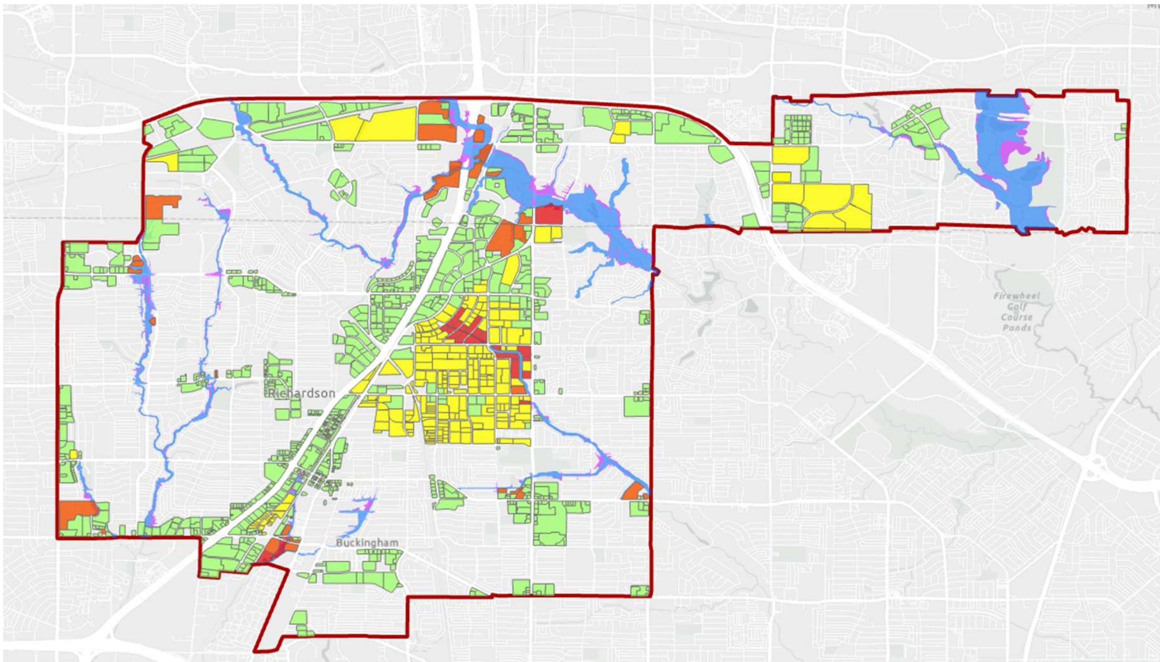

Figure 3 Composite parcel risk in Richardson, TX based on weighted flood, land use, and UST proximity scores, highlighting higher-risk clusters in central commercial and industrial areas.

In my final map I was able to see specific trends. Higher-risk parcels (in orange and red) cluster along major transportation routes like US-75 and around older commercial and industrial zones, where flood exposure, hazardous land uses, and proximity to USTs overlap. This is a trend I expected from my preliminary findings discussed previously. These areas of environmental vulnerability are more visible in the central commercial district and the industrial areas north of Arapaho Road. Parcels in the northern and eastern areas of the city fall into the Low or Moderate categories, reflecting lower flood hazard, fewer USTs, and less intensive land uses.

Using the locate tool, I can search for any address or select a parcel directly to view its weighted composite risk score, along with the individual scores for flood hazard, UST proximity, and land use. One parcel that interested me is located at the University of Texas at Dallas campus. This site was classified as an Elevated Risk parcel (orange), and clicking into the pop-up shows me that it is a multi-family housing in this case I know it is student residential housing. Because this land use supports a vulnerable residential population and the parcel's elevated score is driven by multiple environmental factors, a reasonable recommendation would be to advise the stakeholder to conduct a Phase II subsurface investigation to further assess potential environmental concerns. This is an example of my tool working in action.

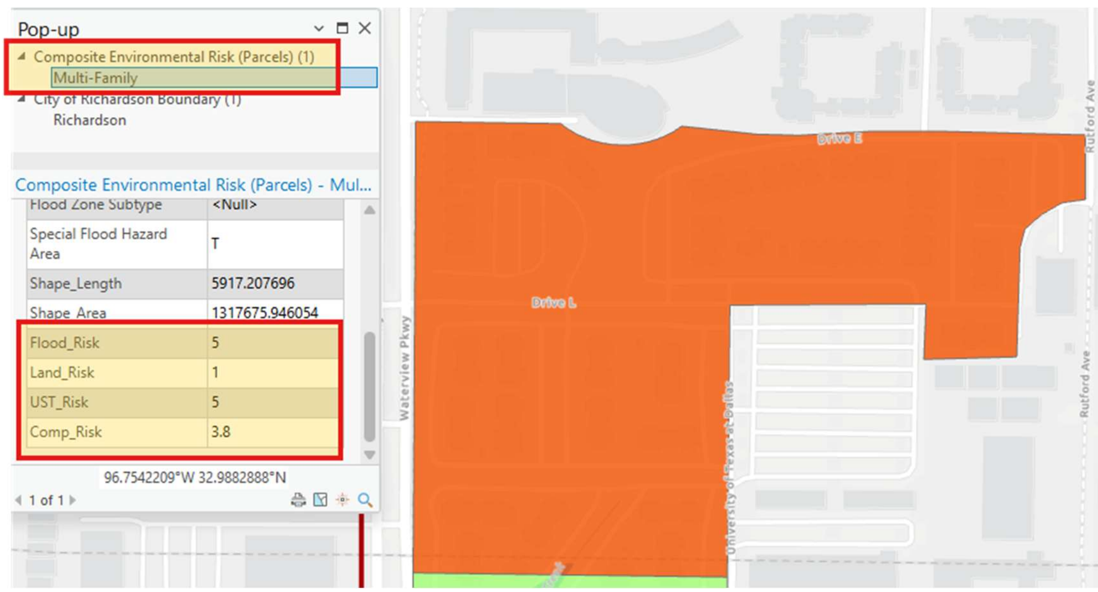

Figure 4 Example of elevated-risk UT Dallas student housing parcel, identified through composite scoring, where further investigation (e.g., Phase II) may be recommended.

Overall, the map highlights a clear concentration of compounded environmental risks in Richardson's core commercial zones, offering useful insight for planning, mitigation, and further environmental assessment.

My project demonstrates how publicly available environmental and zoning datasets can be used to create parcel level environmental risk index. This can be integrated into a

GIS framework, developing the index to better identify potential RECs for lenders, investors and consultants which can then help prioritize further investigations. This methodology is scalable to other cities and counties where parcel and hazard data are available. The advantage of this data is that it is publicly available and does not require pay walls unless a person intends to get their parcel data from a private company. This supports widespread adoption of not just analytics, but GIS based spatial analytics in environmental risk management. As GIS evolves data driven tools can bridge the current disconnect between environmental practices and due diligence with real estate. The goal is to enhance efficiency and transparency in this due diligence process.

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