Table of Contents

2. Introduction

Our research was conducted in the South Christchurch suburb of Beckenham (Figure 1). The research site was an empty piece of land on Hunter Terrace by the Heathcote River and the South Christchurch Library.

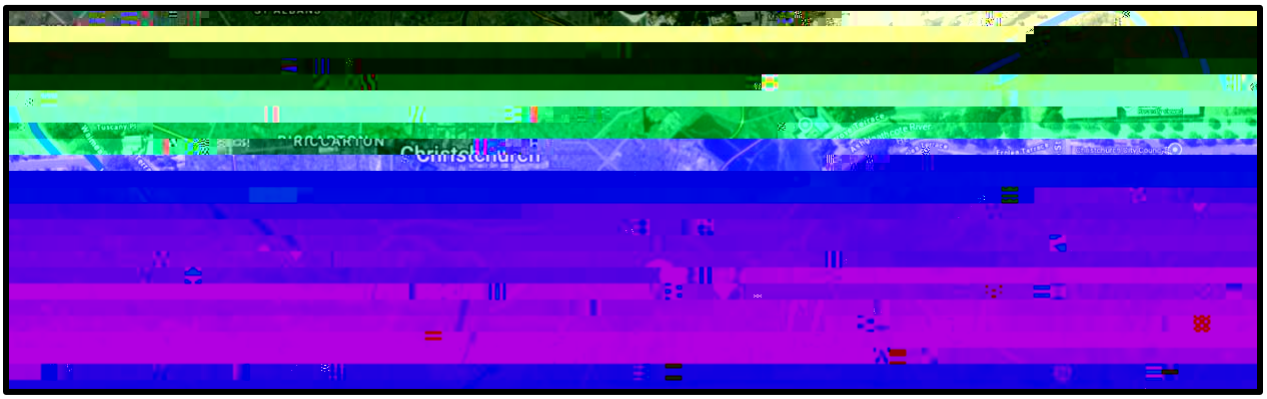

Figure 1. *Location of the research site in Beckenham, South Christchurch.*

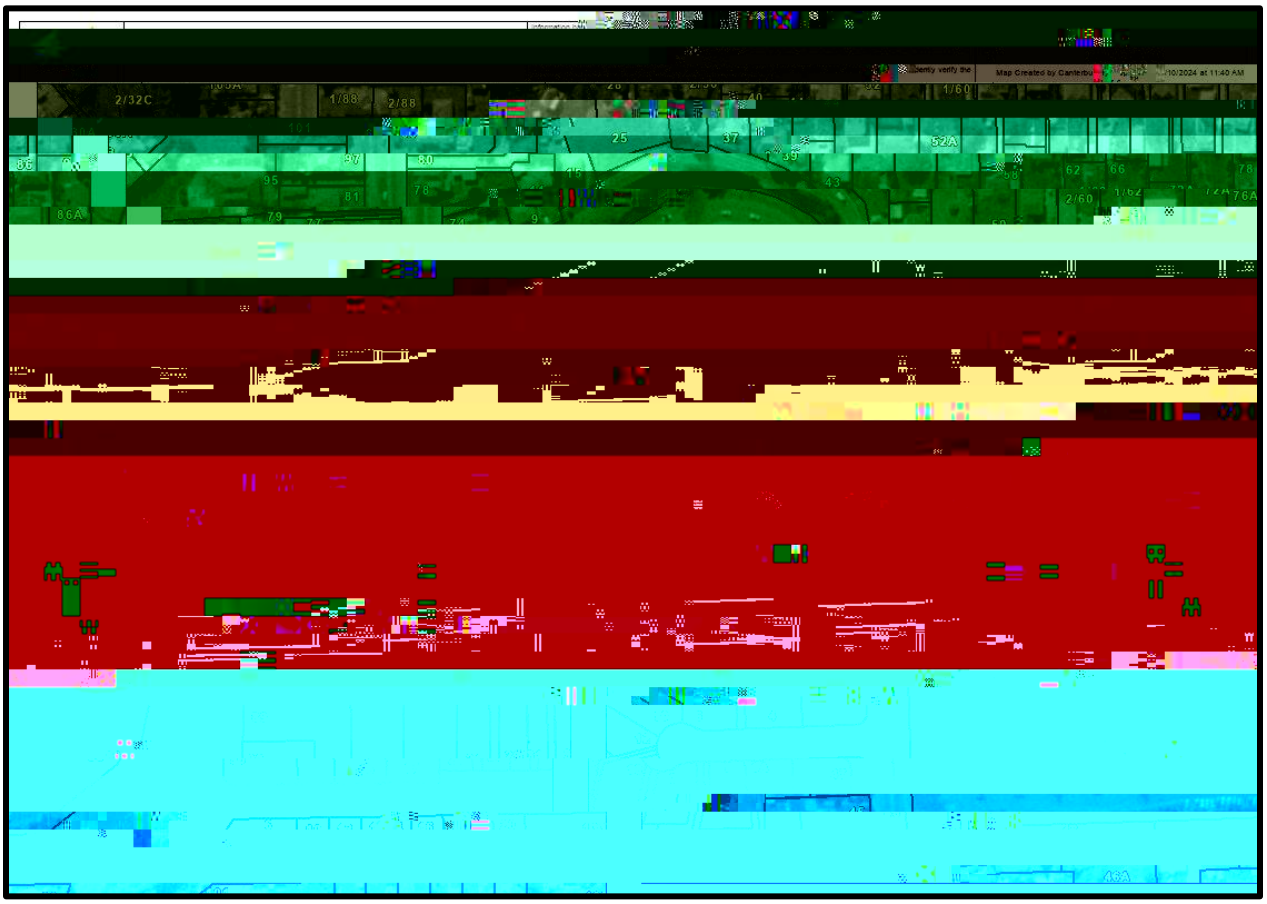

Figure 2. Historical Image of Beckenham, 1980-1984. (Canterbury Maps)

Figure 3. Preliminary pump track design

Upon initial consultation with the Beckenham Neighbourhood Association, we developed our research question: Is the soil in the Beckenham Bike Pump Track contaminated? If so, to what extent, and what mitigation strategies could be implemented that align with the interests of the community? This question addressed the key concerns of our community partners while remaining feasible within the project's timeframe.

3. Literature Review

To gain a comprehensive understanding of our project and methods involved with it, our group reviewed a wide range of background literature relevant to our research question. These included: effects of bike pump tracks on communities; potential contaminants of concern; sampling methods; exposure pathways; and remediation options and communicating these to the public.

Our research question directly relates to broader literature on contaminated land management, particularly in urban spaces. Studies on heavy metal contamination from industrial residues, such

Our project also aligns with the interests of our community partners, the Beckenham Neighborhood Association, who raised concerns about potential contamination on the site due to the historical spreading of gasworks residue (Beckenham Neighborhood Association, 1993). Their goal is to create a safe recreational space for children and the wider community, making our research essential in providing the necessary data to inform the safe development of the pump track. By addressing both the scientific literature and the co
bridged academic research with practical, local needs.

Due to the knowledge of historical contamination, we conducted a review of relevant literature on gasworks contamination. Papers by Ashrafzadeh et al. (2018) and Ajmone-Marsan & Biasioli (2010) deepened our understanding of health concerns related to exposure, while studies by the Ministry for the Environment (1997) and Byers et al. (1994) identified heavy metals and polycyclic aromatic hydrocarbons (PAHs) as the most associated contaminants from gasworks sites. These contaminants often originate from retort houses, coal dumps, gas purifiers, and coal-tar residue. Finally, Weigand et al. (2001) emphasized the importance of considering contaminant mobility, particularly in the leaching of heavy metals, highlighting the importance of sampling at depth to account for this.

A synthesis of Christchurch-based and urban environments contamination studies found the elements of Cu, Zn, As and Pb to be commonly present in soil (Ashrafzadeh et al. (2018); Jordan & Hogan (1975). We also wanted to make sure we were testing for those with significant health impacts as children use this land daily. A review of papers; Ramírez et al., 2021; Tong et al., 2000; Abdul et al., 2015; ATSDR, n.d. helped us understand the health effects of common heavy metals, which helped us confirm testing for

physical barrier such as with concrete between the contaminants and the environment. This is a quick and effective solution, but will still leave the heavy metals beneath the cap. The other was phytoremediation or bioremediation, which works by adding plants to absorb, degrade, or stabilise contaminants in the soil. This has the potential to rid the soil of its contaminants but is a longer-term and slower solution. Since the new track will be capped with asphalt, this provides immediate protection, but understanding these additional methods allows us to implement further measures if needed.

When considering how to present our research to the Beckenham community, Reynolds & Seeger (2005) highlighted the importance of transparent and clear communication in alleviating fear and misinformation. However, our community partners later indicated that they would manage this aspect, so we did not address this further. They w

ution

Brett Robinson and supported by the literature review and were chosen due to time and resource constraints.

Data was collected using portable x-ray fluorescence, taking soil samples and testing them in the lab along with spatial analysis. XRF is quick and accurate at testing for heavy metals, which is why we chose it. Figure 4 shows the 16 locations that samples were taken from. These 16 samples were chosen randomly throughout our site insuring to cover areas that will be capped and uncapped. Random sampling also ensures valid unbiased data (Botha, 2021).

Figure 4. Locations of the 16 soil samples used for XRF analysis

Figure 5

Table 3.

Soil contaminant standards for health ($SCSs_{(health)}$ for inorganic substances (Ministry for the Environment, 2012; Dutch Ministry of Housing, 2010).

Element	Residential 10% (mg/kg)	Recreation (mg/kg)
Copper	> 10,000	> 10,000
Zinc		

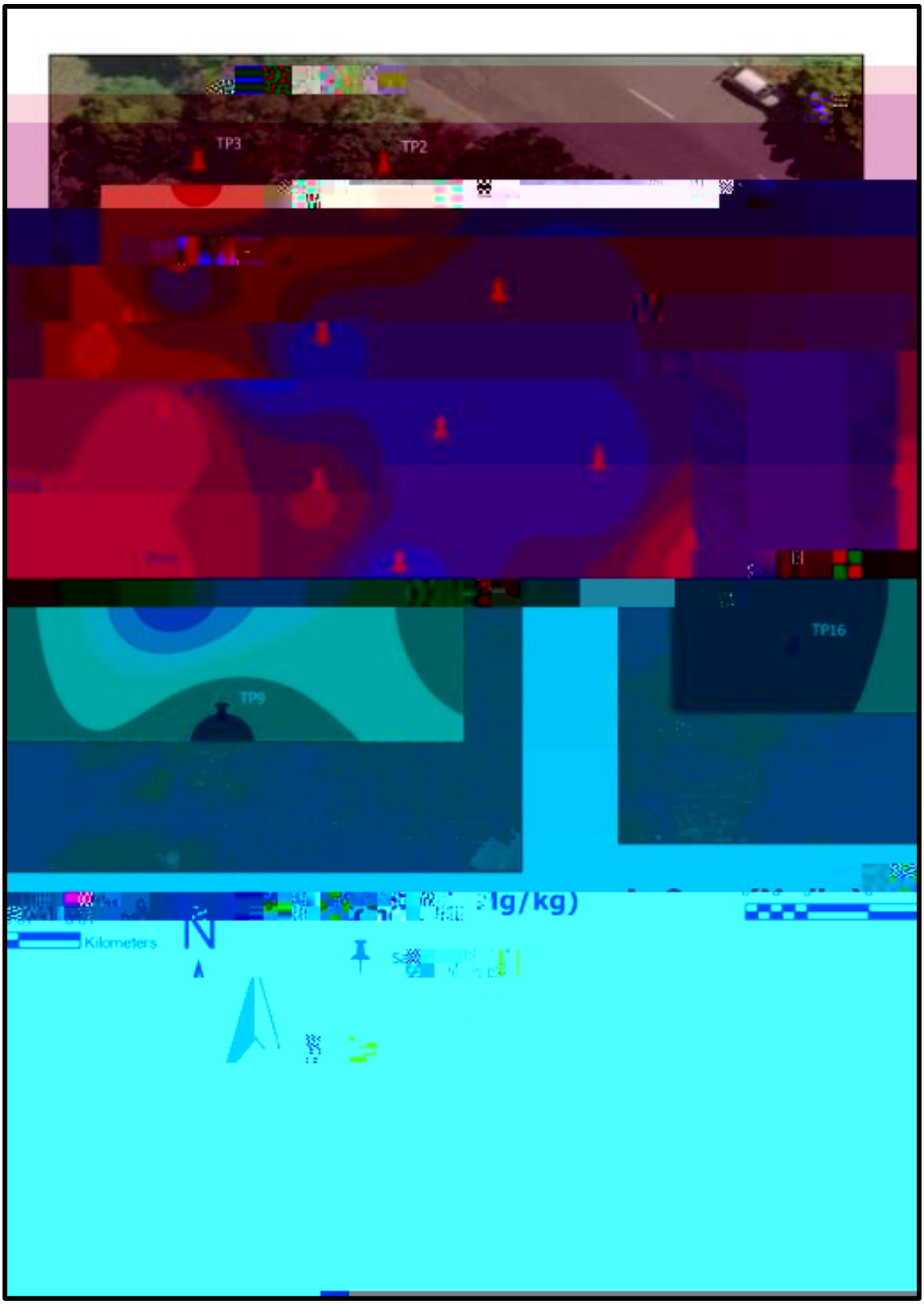

Figure 5. IDW Interpolation Map of Arsenic Concentrations

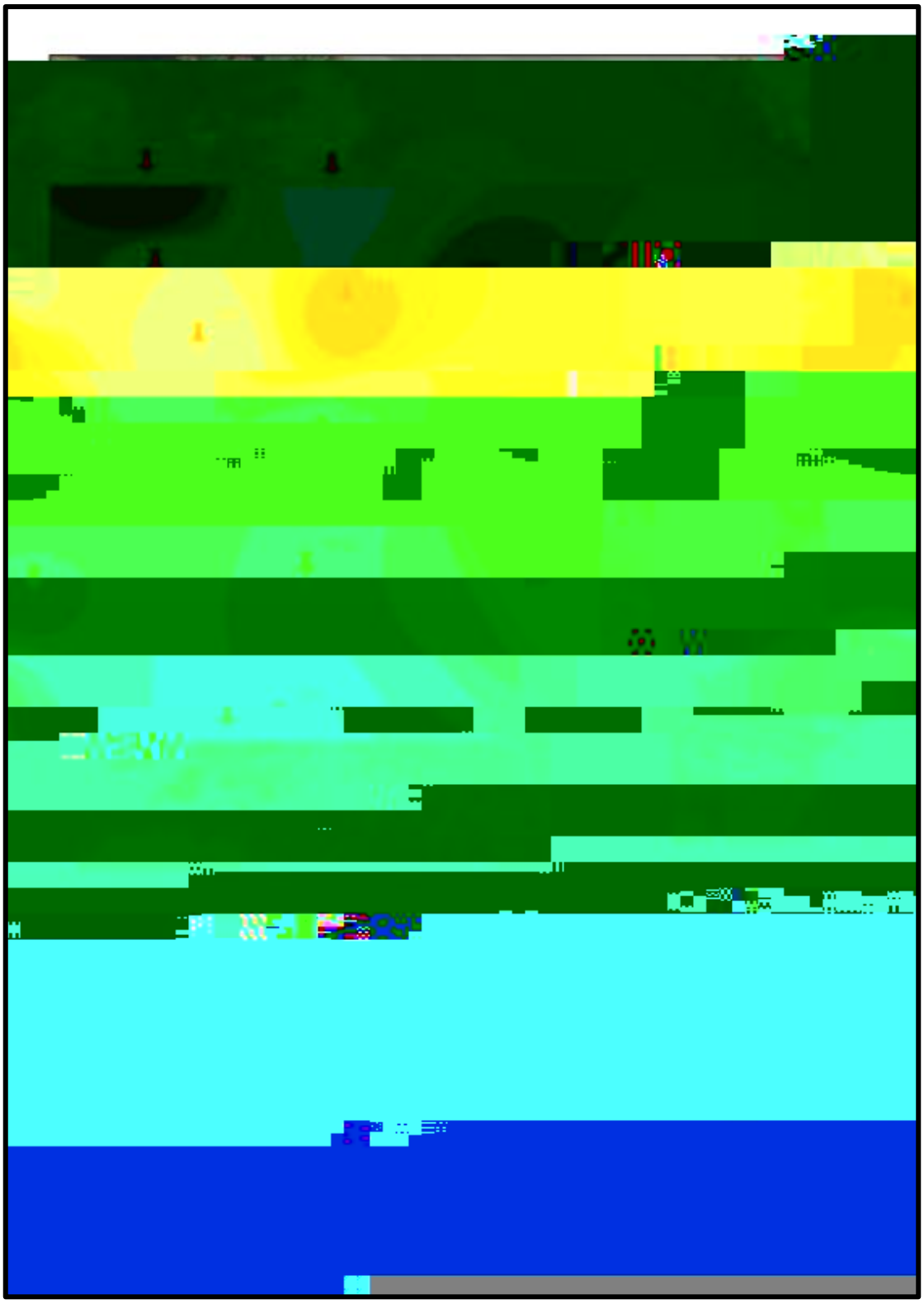

Figure 6. IDW Interpolation Map of Copper Concentrations

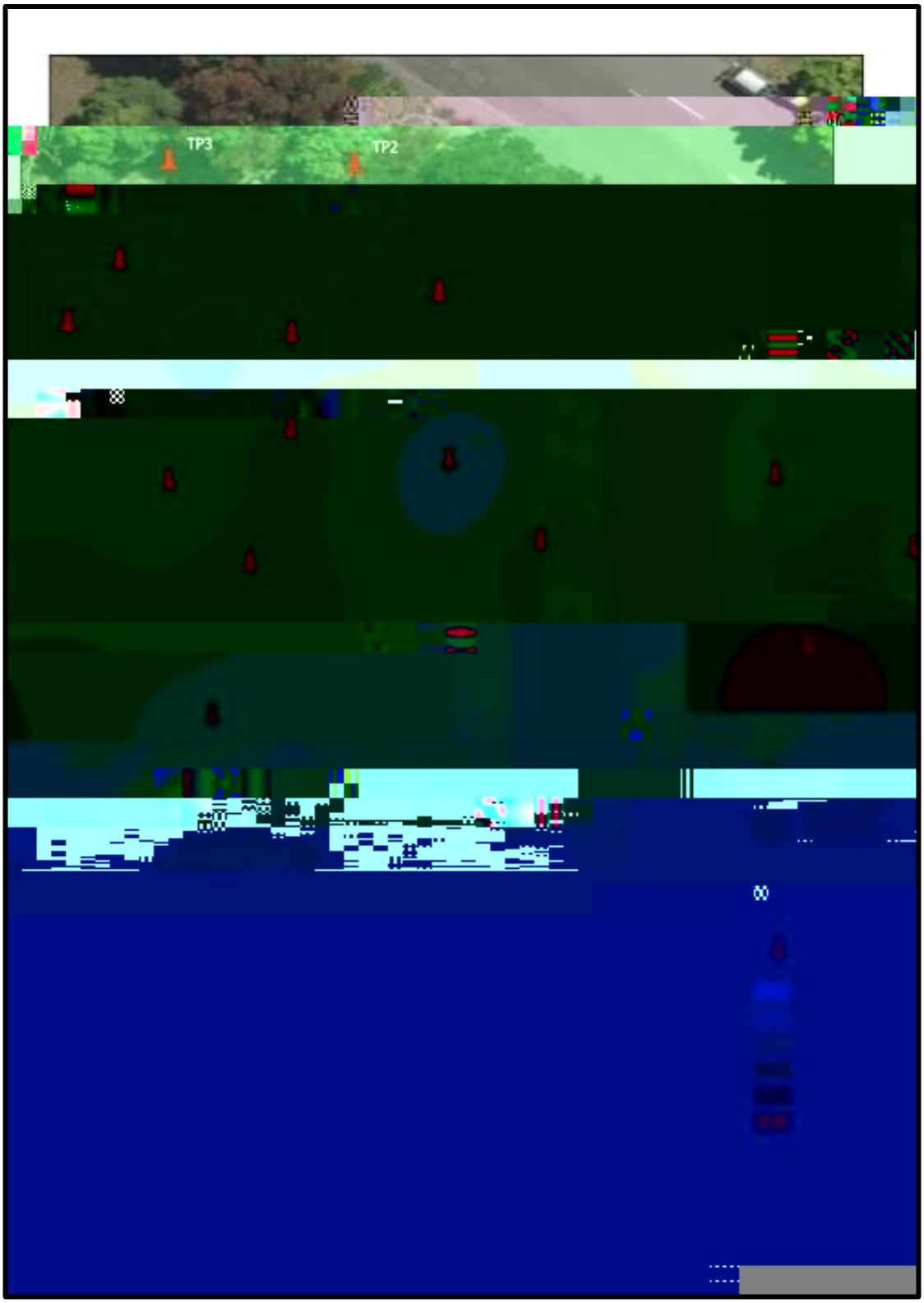

Figure 8. IDW Interpolation Map of Zinc Concentrations

6.3 Limitations

One limitation was the impact that the presence of bitumen had on our research, making it impossible to dig deeper than 10-20cm with just the spade we had. This meant we could not test

7. Conclusion

Our research combined historical site evaluation, field sampling, and data analysis to assess potential contamination at the Beckenham pump track site. Utilising a range of resources such as historical records, imagery from Retrolens and Canterbury Maps, geological data from S-map, and past community surveys we established a comprehensive understanding of the site's background, past land use, and present opinions on the land. XRF testing and ICP-MS lab analysis measured heavy metal concentrations, and the results were mapped using ArcGIS Pro for spatial interpolation. These findings, guided by NESCS guidelines for human health and the background concentrations of these heavy metals in the area, informed us that this land is not contaminated at the depths we sampled at. This analysis will inform future decision-making to ensure the safe development of the site into an official community facility.

8. Acknowledgements

We would like to acknowledge and thank the ongoing support from Georgie Rule, Brett Robinson and our community partners, Mike Fisher and Dave Kelly, for contributing their time and expertise to our project. We would also like to acknowledge Chris Grimshaw who assisted with laboratory inductions and ICP-MS testing.

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10. Appendices

Appendix 1: ICP-MS Results